VII. APPENDIX I

AIR SAMPLING PRACTICES FOR ARSENIC

General Requirements

Air concentrations shall be determined within the worker's breathing zone and shall meet the following criteria in order to evaluate conformance with the standard:

(a) Samples collected shall be representative of the individual worker's exposure.

(b) Sampling data sheets shall include:

   (1) The date and time of sample collection

   (2) Sampling duration

   (3) Volumetric flowrate of sampling

   (4) A description of the sampling location

   (5) Other pertinent information

Breathing Zone Sampling

(a) Breathing zone samples shall be collected as near as practicable to the worker's face without interfering with his freedom of movement and shall characterize the exposure from each job or specific operation in each production area.

(b) A portable battery-operated personal sampling pump plus an unweighed 0.8 μ cellulose membrane filter (Type AA) mounted in either a 2- or 3-piece cassette shall be used to collect the sample.

(c) The sampler shall be operated at a flowrate of two liters per minute and samples taken for at least 15 minutes. A sampling time of 30 to 60 minutes is recommended.

(d)   A minimum of three samples shall be taken for each operation (more samples if the concentrations are close to the standard) and averaged on a time-weighted basis.

(e)   A minimum of three blank filters carried in closed cassettes to the sampling site shall be provided to the analytical laboratory to determine the background correction which must be applied to the analytical results.

Calibration of Sampling Trains

Since the accuracy of an analysis can be no greater than the accuracy of the volume of air which is measured, the accurate calibration of a sampling pump is essential to the correct interpretation of the volume indicated. The frequency of calibration is dependent on the use, care, and handling to which the pump is subjected. In addition, pumps should be recalibrated if they have been subjected to misuse or if they have just been repaired or received from a manufacturer. If the pump receives hard usage, more frequent calibration may be necessary.

Ordinarily, pumps should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The accuracy of calibration is dependent on the type of instrument used as a reference. The choice of calibration instrument will depend largely upon where the calibration is to be performed. For laboratory testing, a 1-liter burette or wet test meter is recommended, although other standard calibrating instruments such as spirometer, Marriott's bottle, or dry-gas meter can be used. The actual set-up will be the same for these instruments.

Instructions for calibration with the wet test meter follow. If another calibration device is used, equivalent procedures should be followed.

(a)   The calibration device used shall be in good working condition and shall have been calibrated against a soapbubble meter, spirometer, or other primary standard upon procurement, after each repair, and at least annually.

(b)   Calibration curves shall be established for each sampling pump and shall be used in adjusting the pumps prior to field use.

(c)   The volumetric flowrate through the sampling system shall be spot checked and the proper adjustments made before and during each study to assure obtaining accurate airflow data.

(d)   Flowmeter Calibration Test Method (see Figure XI-1)

(1)   Apparatus

(A)   Wet test meter

(B)   Quick connector or by-pass valve

(C)   In-line filter holder cassette with Type AA filter

(D)   Tee

(E)   Manometer

(F)   Pump with rotameter

(G)   Rubber or vinyl tubing

(H)   Barometer

(I)   Thermometer

(J)   Stopwatch

(K)   Small screwdriver

(L)   Graph paper

(2)   Procedures

(A)   Level wet test meter.   Check the water level which should just touch the calibration point at the left side of the meter.   If water level is low, add water 1 to 2 F warmer than room temperature to fill point.   Run the meter for 30 minutes before calibration.

(B)   Check the voltage of the pump battery with a voltmeter.   This test is most indicative of battery conditions when performed under full load, ie with the pump motor operating.

(C)   Mount the filter to be calibrated in the in-line filter holder.

(D)   Assemble the calibration train as shown in Figure XI-1.   Leave the quick connector disconnected.

(E)   Turn the pump on, adjusting the rotameter with a screwdriver to a reading of 10 (read middle of the float).

(F)   Connect the wet test meter to the train.   The pointer on the meter should run clockwise and a pressure drop of not more than 1.0 inch of water indicated.   If the pressure drop is greater than 1.0 disconnect and check the system.

(G)   Operate the system ten minutes before starting the calibration.

(H)   Record the following on calibration data sheets:

(i)   Wet test meter reading, start and finish

(ii)   Elapsed time, start and finish

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(iii)   Pressure drop at manometer

(iv)   Air temperature

(v)   Barometric pressure

(vi)   Serial number of pump and rotameter

(I)   Adjust the rotameter reading to 9.0, 8.0, and 7.0, respectively, and repeat step (H) at each reading. For each point, the system should run for 10 minutes or sample at least 0.5 cubic foot of air.

(J)   Record the name of the person performing the calibration, the date, serial number of the wet test meter, and the numbers of the pump and flowmeter system being calibrated.

(K)   Corrections to the flow rate may be necessary if the pressure or temperature when samples are collected differs significantly from that when calibration was performed. Flow rates may be calculated using the following formula:

$$q(actual) = q(indicated) \cdot \sqrt{\frac{P(calibrated)}{P(actual)} \cdot \frac{T(calibrated)}{T(actual)}}$$

where q = volumetric flowrate

P = pressure

T = temperature (in degrees Kelvin or Rankine)

(L)   Use graph paper to record the actual airflow as the ordinate and the rotameter readings as the abscissa.

VIII. APPENDIX II

ANALYTICAL METHOD FOR

ARSENIC IN AIR [69,70]

Treatment of Sample: The filter or precipitator sample is rinsed into a beaker with a stream of 1% sodium hydroxide solution, followed by a distilled water rinse. The volumes of both rinse liquids are kept at a minimum. The alkali is neutralized by dropwise addition of concentrated hydrochloric acid using phenolphthalein indicator. The cooled solution is transferred and made up to 50 ml in a volumetric flask. Impinger samples are made up to a 50 or 100 ml final volume as convenient. If water was used in the impinger no neutralization is required.

Analysis: Known microgram amounts of arsenic (1-15 µg) in the form of standard arsenic solution, are pipetted into 125 ml Erlenmeyer flasks. Distilled water is added to make the total volume 35 ml. To the flasks are added 5 ml hydrochloric acid, 2 ml 15% potassium iodide solution, and 8 drops of stannous chloride solution. The flasks are swirled, and allowed to stand for 15 minutes to ensure reduction of all arsenic to the trivalent form.

Three milliliters of the pyridine solution of silver diethyl-dithiocarbamate are placed in the absorbing tube, which is attached to the scrubber containing glass wool impregnated with lead acetate.

The ground joints are lubricated with stopcock grease, 3 g of granulated zinc are added to the solution in the flask, and the receiving tube is inserted immediately. Arsine evolution is completed in about 30 minutes.

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At the end of this time the absorbing solution is transferred to a square 1 cm cell and the absorbance measured at 560 nanometers in a spectrophotometer. Plotting measured absorbances against micrograms of arsenic taken produces the standard curve. Care should be taken when preparing standard curves, since some arsenic can leach from new glassware and could influence a standard curve.

Air samples, after the previously described preparation treatment, are treated in the same manner as the standards. Depending upon the operator's knowledge of the sampling conditions, a sample or aliquot of a sample representing from 1.0 to 15.0 μg of arsenic should be taken for analysis. From previous experience with known amounts of arsenic the operator can decide from the color of the absorbing solution whether the sample aliquot taken will be within the range of the calibration curve. If necessary, the prepared sample may be diluted, or the volume of the absorbing solution may be varied to adjust the color intensity to the scale of the standard curve.

Chemical Reaction: Arsenic, in the form of arsine, displaces an equivalent amount of silver from silver diethyldithiocarbamate in pyridine solution.

Calculations: If a 25 ml aliquot of a 50 ml prepared sample is taken for analysis, and 3 ml of absorbing solution are used, the arseni concentration in milligrams per cubic meter is:

$$\frac{2 \text{ X micrograms arsenic from curve}}{1000 \text{ X volume of air sampled in cubic meters}}$$

Range and Sensitivity: If suitable samples (10 cu m of air) are available, concentrations as low as 0.1 µg As/cu m can be measured. The maximum measurable concentration with a comparable sample is 1.5 µg As/cu m. Higher concentrations can be measured if smaller samples are used.

Precision and Accuracy: Samples containing 0.1, 1.0, 5.0, and 10.0 µg As were analyzed [70] with an accuracy of ±0.04 µg based on 7 replicate determinations at each concentration. Four samples containing arsenic were analyzed [70] by eight laboratories and the percent average deviation from the arsenic actually present was calculated:

Sample	Arsenic present	Percent average
	µg As/ml	deviation
1	0.05	9.1
2	0.50	3.5
3*	1.00	6.1
4	1.50	4.0

*Contained 0.5 µg Sb/ml

Interferences: The only substances likely to interfere with the test are hydrogen sulfide, which is normally removed by the lead acetate glass wool plug, and stibine. Sample 3 above [70] contained 0.5 µg Sb/ml in addition to the arsenic present. The results indicate that stibine, due to antimony present in the sample, does not interfere in the amount present.

Special Equipment: The equipment illustrated in Figure XI-2 has been found convenient, easy to construct and clean, and suitable for mass

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production of results. It is available commercially or may be built. Other arrangements of glassware have been used with success, such as a standard borosilicate glass Gutzeit generator connected to a glass delivery tip extending into absorbing solution contained in a Kahn tube. A spectrophotometer, with or without photomultiplier, or any good colorimeter may also be used.

Reagents: Silver diethyldithiocarbamate [AgSCSN(C2H5)2] reagent: Dissolve 4.0 g of silver diethyldithiocarbamate in 800 ml of pyridine. The useful life of this reagent can be extended to at least two months by storing in a dark brown bottle or in the dark.

Stannous chloride reagent: Dissolve 10.0 g of fresh supply of stannous chloride dihydrate in 25 ml of 12N (specific gravity 1.19) hydrochloric acid. Place in a separatory funnel with a layer of pure mineral oil 5 mm thick on top to minimize oxidation. Drain a small quantity of the solution out of the stopcock before use. This solution is stable for 2 weeks.

Lead acetate solution: Dissolve 10 g of Pb(C2H3O2)2 3H2O crystals in 100 ml of water. The solution will be slightly turbid as a small amount of the basic salt is formed, but this will not affect its usefulness. The glass wool in the scrubber may be soaked in this solution, drained, and dried, or a few drops may be placed on the glass wool before the evolution of arsine.

Potassium iodide solution: Dissolve 15 g of KI in 100 ml of water. The solution should be stored in a brown glass bottle.

Zinc: Reagent grade, granular 20 mesh.

Arsenic standard stock solution: 1.320 g arsenic trioxide is dissolved in 10 ml of 40% sodium hydroxide and diluted to 1 liter with distilled water. Various strengths of standard solutions are prepared by further diluting this stock solution with suitable volumes of water.

The water used to make up the reagents, and throughout the analysis, is triple distilled in borosilicate glass. Naturally, all reagents used should be checked to ensure a low individual and a low total reagent blank.

IX. APPENDIX III

ANALYTICAL METHOD FOR

ARSENIC IN URINE [68-70]

At least 100 ml of urine should be collected. Determine the specific gravity of the sample before further treatment.

Oxidation: Place 100 ml of urine in a 300 ml Kjeldahl flask, add 5 ml concentrated H_2SO_4 and 25 ml concentrated HNO_3. Boil over a full flame under the hood. The addition of acid may cause the sample to darken, but the heating will lighten the color. Continue the heating to concentrate the sample. No trouble should be experienced with bumping. As the sample becomes quite concentrated, it will foam considerably. At this point it should be watched carefully for signs of darkening. If there is darkening, add a few drops of concentrated HNO_3 from a pipette dipped into a tube of the acid. Only sufficient acid should be added to overcome the darkening. Finally, the liquid should be water-white and fumes of sulfuric acid will be evolved. Further bleaching of the solution may be obtained by cautiously adding 2 ml of a 1:1 mixture of nitric and perchloric acids, and reheating to produce white fumes. Cool slightly and add 5 ml of saturated ammonium oxalate. Heat again until white fumes appear. This oxidation may be completed in less than two hours.

Analysis: Transfer the oxidized sample with the aid of 25 ml of water to a 100 ml conical flask. Cool to room temperature. Add 5 ml of 10% potassium iodide and 4 drops of stannous chloride. Let stand 15 minutes. Add 3.0 g of zinc and, using the same equipment as in determining

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arsenic in air (see Figure XI-2), follow the same procedures as for air samples.

Calculations: Determine absorbance produced by 10 or 20 µg As at 560 nm. For example, if the increase in absorbance produced by 10 µg As is found to be 0.440, then:

$$\frac{(A-B)}{0.044} = \text{µg in aliquot}$$

where A = absorbance in sample, and B = absorbance of blank run on reagents. Calculate as mg As/liter of urine. Adjust to mean specific gravity of 1.024.

Reagents: Prepare as in analysis for determination of arsenic in air.

X. APPENDIX IV

MATERIAL SAFETY DATA SHEET

The following items of information which are applicable to a specific product or material containing arsenic or arsenic compounds shall be provided in the appropriate section of the Material Safety Data Sheet or other approved form. If a specific item of information is inapplicable (eg, flash point), the initials "n.a." (not applicable) should be inserted.

(a)   The product designation in the upper left hand corner of both front and back to facilitate filing and retrieval.   Print in upper case letters as large as possible.

(b)   Section I. Name and Source.

(1)   The name, address, and telephone number of the manufacturer or supplier of the product.

(2)   The trade name and synonyms for a mixture of chemicals, a basic structural material, or for a process material; and the trade name and synonyms, chemical name and synonyms, chemical family, and formula for a single chemical.

(c)   Section II. Hazardous Ingredients.

(1)   Chemical or widely recognized common name of all hazardous ingredients.

(2)   The approximate percentage by weight or volume (indicate basis) which each hazardous ingredient of the mixture bears to the whole mixture. This may be indicated as a range or maximum amount, eg, 10-20% V; 10% max. W.

(3)   Basis for toxicity for each hazardous material such as established OSHA standard (TLV), in appropriate units and/or LD50, showing amount and mode of exposure and species or LC50 showing concentration and species.

(d)   Section III. Physical Data.

Physical properties of the total product including boiling point and melting point in degrees Fahrenheit; vapor pressure, in millimeters of mercury, vapor density of gas or vapor (air = 1), solubility in water in parts per hundred parts of water by weight; specific gravity (water = 1); percent volatile, indicate if by weight or volume, at 70 Fahrenheit; evaporation rate for liquids (indicate whether butyl acetate or ether = 1); and appearance and odor.

(e)   Section IV. Fire and Explosion Hazard Data.

Fire and explosion hazard data about a single chemical or a mixture of chemicals, including flash point, in degrees Fahrenheit; flammable limits, in percent by volume in air; suitable extinguishing media or agents; special fire fighting procedures; and unusual fire and explosion hazard information.

(f)   Section V. Health Hazard Data.

Toxic level for total compound or mixture, relevant symptoms of exposure, skin and eye irritation properties, principal routes of absorption, effects of chronic (long-term) exposure and emergency and first aid procedures.

(g)   Section VI. Reactivity Data.

Chemical stability, incompatibility, hazardous decomposition products, and hazardous polymerization.

(h)   Section VII. Spill or Leak Procedures.

Detailed procedures to be followed with emphasis on precautions to be taken in cleaning up and safe disposal of materials leaked or spilled. This includes proper labeling and disposal of containers containing residues, contaminated absorbants, etc.

(i)   Section VIII. Special Protection Information.

Requirements for personal protective equipment, such as respirators, eye protection and protective clothing, and ventilation such as local exhaust (at site of product use or application), general, or other special types.

(j)   Section IX. Special Precautions.

Any other general precautionary information such as personal protective equipment for exposure to the thermal decomposition products listed in Section VI, and to particulates formed by abrading a dry coating, such as by a power sanding disc.

(k)   The signature of the responsible person filling out the data sheet, his address, and the date on which it is filled out.

PRODUCT DESIGNATION	MATERIAL SAFETY DATA SHEET

MATERIAL SAFETY
DATA SHEET

Form Approved
Budget Bureau No.
Approval Expires
Form No. OSHA
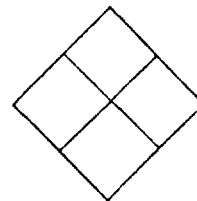
SECTION I SOURCE AND NOMENCLATURE

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, ZIP Code)	
TRADE NAME AND SYNONYMS	CHEMICAL FAMILY
CHEMICAL NAME AND SYNONYMS	FORMULA

SECTION II HAZARDOUS INGREDIENTS

BASIC MATERIAL	APPROXIMATE OR MAXIMUM % WT. OR VOL.	ESTABLISHED OSHA STANDARD	LD 50		LC 50	
			ORAL	PERCUT.	SPECIES	CONC.

SECTION III PHYSICAL DATA

BOILING POINT	°F.	VAPOR PRESSURE	mm Hg.
MELTING POINT	°F.	VAPOR DENSITY (Air=1)	
SPECIFIC GRAVITY (H$_2$0=1)		EVAPORATION RATE (_____ =1)	
SOLUBILITY IN WATER	Pts/100 pts H$_2$O	VOLATILE % Vol. % Wt.	
APPEARANCE AND ODOR			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT	FLAMMABLE (EXPLOSIVE) LIMITS	UPPER
METHOD USED		LOWER
EXTINGUISHING MEDIA		
SPECIAL FIRE FIGHTING PROCEDURES		
UNUSUAL FIRE AND EXPLOSION HAZARDS		

SPECIAL FIRE FIGHTING

PRODUCT DESIGNATION	

SECTION V HEALTH HAZARD DATA	
TOXIC LEVEL	CARCINOGENIC
PRINCIPAL ROUTES OF ABSORPTION	SKIN AND EYE IRRITATION
RELEVANT SYMPTOMS OF EXPOSURE	
EFFECTS OF CHRONIC EXPOSURE	
EMERGENCY AND FIRST AID PROCEDURES	

SECTION VI REACTIVITY DATA
CONDITIONS CONTRIBUTING TO INSTABILITY
CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION
INCOMPATIBILITY (Materials to Avoid)
HAZARDOUS DECOMPOSITION PRODUCTS

SECTION VII SPILL OR LEAK PROCEDURES
STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
WASTE DISPOSAL METHOD

SECTION VIII SPECIAL PROTECTION INFORMATION	
VENTILATION REQUIREMENTS LOCAL EXHAUST	PROTECTIVE EQUIPMENT (Specify Types) EYE
MECHANICAL (General)	GLOVES
SPECIAL	RESPIRATOR
OTHER PROTECTIVE EQUIPMENT	

SECTION IX SPECIAL PRECAUTIONS
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE
OTHER PRECAUTIONS

Signature _____   Address

Date

TABLE XI-1

PHYSICAL AND CHEMICAL PROPERTIES OF
IMPORTANT INORGANIC ARSENICALS

Arsenic, As
     Physical state: gray metal, hexagonal-rhombic crystals
      also yellow cubic crystals (As4)
     Atomic weight: 74.9216
     Specific gravity: 5.727
     Melting point: sublimes at 613 C
     Solubility: insoluble in water

Arsenic Trichloride, AsC13
     Physical state: oily liquid or needle shaped crystals
     Formula weight: 181.28
     Specific gravity: 2.163 (20 C)
     Melting point: -8.5 C
     Boiling point: 130.2 C
     Vapor density: 6.25 (air = 1)
     Vapor pressure: 10 mm Hg (23.5 C)
     Solubility: decomposes in water
     Percent arsenic: 41

Arsenic Trioxide, As2O3 (White Arsenic, Arsenous Oxide)
     Physical state: transparent crystals or amorphous white powder
     Formula weight: 197.84
     Specific gravity: 3.738
     Melting point: 315 C
     Solubility, in g/100cc water: 3.7 at 20 C, 10.14 at 100 C
     Percent arsenic: 76

Arsenic Pentoxide, As2O5 (Anhydride of Arsenic Acid)
     Physical state: deliquescent, white amorphous powder
     Formula weight: 229.84
     Specific gravity: 4.32
     Melting point: decomposes at 315 C
     Solubility, in g/100cc water: 150 at 16 C, 76.7 at 100 C
     Percent arsenic: 65

Calcium Arsenate, Ca3(AsO4)2
     Physical state: colorless amorphous powder
     Formula weight: 398.08
     Specific gravity: 3.62
     Melting point: 1455
     Solubility, in g/100cc water: 0.013 at 25 C
     Percent arsenic: 38; also occurs with 3 moles of water,
      in which case the molecular weight is 452.11, and the percent
      arsenic is 33.

TABLE XI-1 (CONTINUED)

Copper Acetoarsenite, 3 Cu(AsO2)2-Cu(COOCH3)2 (approx)
        (Copper Acetate Metarsenate, Imperial, Schweinfurth, Vienna,
         Parrot or Paris Green)
        Physical state: emerald green powder
        Formula weight: 1013.77
        Solubility: insoluble in water
        Percent arsenic: 44

Cupric Arsenite, CuHAsO3 (approx) (Scheele's Green, Swedish Green)
        Physical state: yellowish green powder
        Formula weight: 187.47
        Melting point: decomposes
        Solubility: insoluble in water
        Percent arsenic: 40

Lead Arsenate, Pb3(AsO4)2 (Lead Orthoarsenate)
        Physical state: white crystals
        Formula weight: 899.41
        Melting point: 1042 C, slightly decomposes at 1000 C
        Solubility: very slightly soluble in cold water
        Specific gravity: 7.8
        Percent arsenic: 17

Lead Arsenite, Pb(AsO2)2 (Lead Metarsenite)
        Physical state: white powder
        Formula weight: 421.03
        Specific gravity: 5.85
        Solubility: insoluble in cold water
        Percent arsenic: 36

Ortho-Arsenic Acid, H3AsO4-1/2H2O
        Physical state: white translucent hygroscopic crystals
        Formula weight: 150.95
        Specific gravity: 2.0 to 2.5
        Melting point: 35.5 C
        Boiling point: 160 C
        Solubility, in g/100cc: 16.7 in cold water
                                 50 in hot water
        Percent arsenic: 50

Sodium Arsenite, NaAsO2 (Sodium Metarsenite)
        Physical state: gray-white powder
        Formula weight: 129.91
        Specific gravity: 1.87
        Solubility: very soluble in water
        Percent arsenic: 58

From references [5,7]

TABLE XI-2
OCCUPATIONS WITH POTENTIAL ARSENIC EXPOSURE

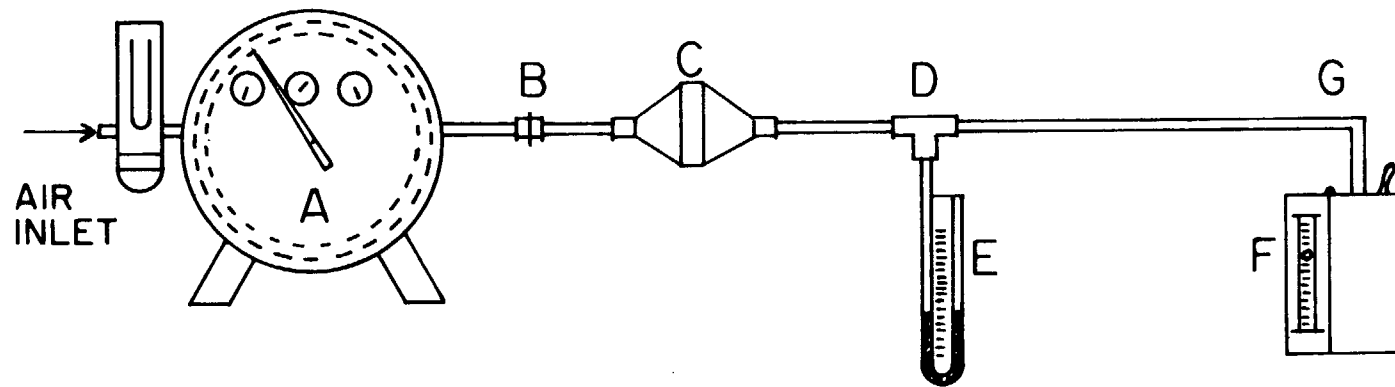|	
alloy makers	hide preservers
aniline color makers	insecticide makers
Babbitt metal workers	lead shot makers
boiler operators	lead smelters
brass makers	leather workers
bronze makers	paint makers
bronzers	painters
cattle dip workers	petroleum refinery workers
ceramic enamel makers	pigment makers
ceramic makers	printing ink workers
copper smelters	rodenticide makers
defoliant applicators	semiconductor compound makers
defoliant makers	sheep dip workers
drug makers	silver refiners
dye makers	taxidermists
enamelers	textile printers
farmers	tree sprayers
fireworks makers	type metal workers
glass makers	water weed controllers
gold refiners	weed sprayers
hair remover makers	wood preservative makers
herbicide makers	wood preservers

From reference [9]

TABLE XI-3
1965 SMELTER SURVEY
ATMOSPHERIC ARSENIC CONCENTRATIONS (mg As/cu m)

"Heavy exposure area" as classified by Lee and Fraumeni [49]

Arsenic Roaster Area   Mean: 1.47
            0.10   0.20   Median: 0.185
            0.10   0.22
            0.10   0.25
            0.10   0.35
            0.10   1.18
            0.10   5.00
            0.17   12.66

"Medium exposure areas" as classified by Lee and Fraumeni [49]

Reverberatory Area   Mean: 1.56
            0.03   0.93   Median: 0.88
            0.22   1.00
            0.23   1.27
            0.36   1.60
            0.56   1.66
            0.63   1.84
            0.66   1.94
            0.76   2.06
            0.78   2.76
            0.78   3.40
            0.80   4.14
            0.83   8.20

Treater Building and Arsenic Loading   Mean: 1.50
            0.10   0.48   Median: 0.295
            0.10   0.62
            0.10   3.26
            0.11   7.20

"Light exposure areas" as classified by Lee and Fraumeni [49]

Copper Concentrate Transfer System   Mean: 0.70
            0.25   Median: 0.65
            0.65
            1.20

Samples from Flue Station   Mean: 0.17
            0.10   Median: 0.17
            0.24

Reactor Building   Mean: 0.004
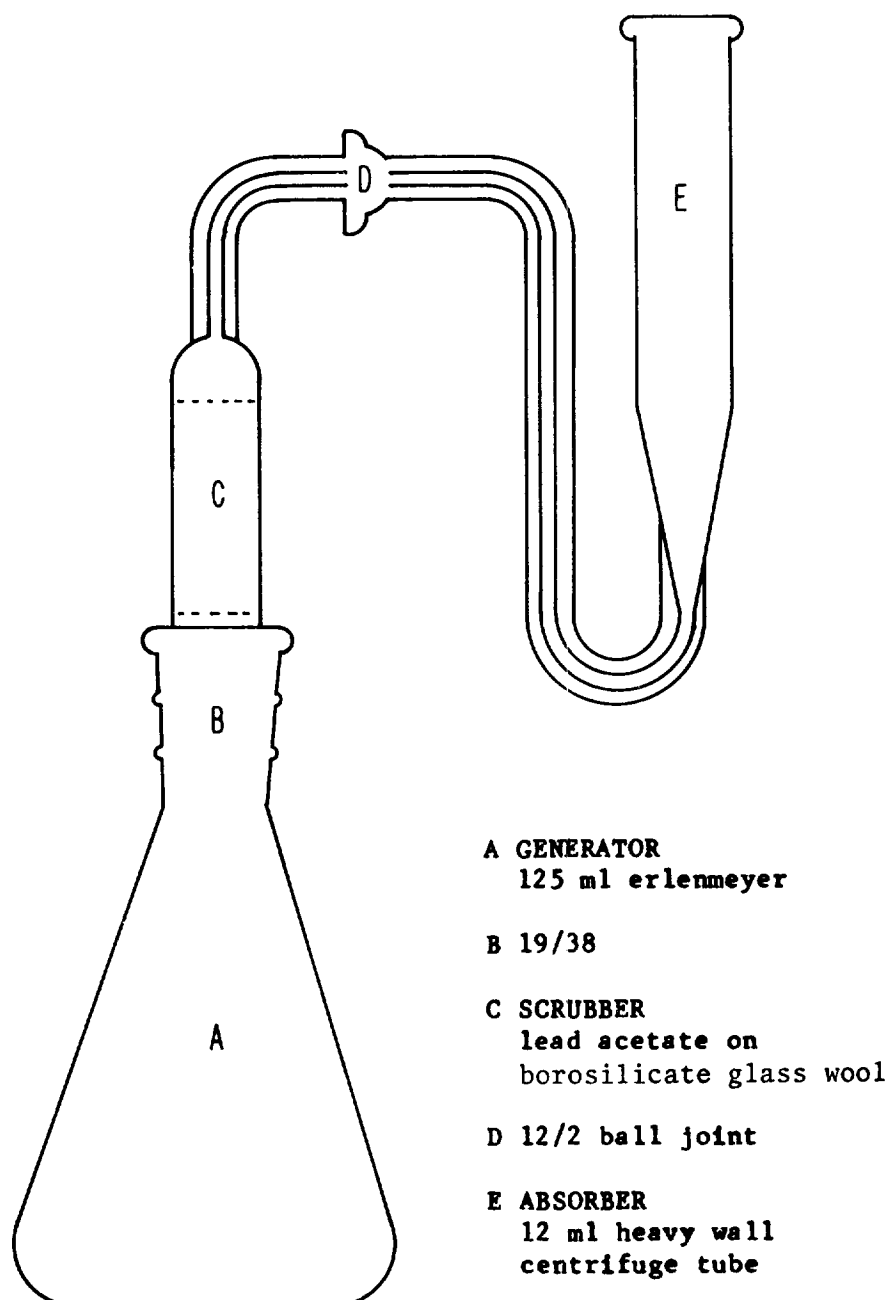   0.001   0.003   Median: 0.002
            0.002   0.009
            0.002   0.010
            0.002

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TABLE XI-4
1965 SMELTER SURVEY
URINARY ARSENIC

Job Title	mg As/liter of urine
Rapper	0.06
Stack foreman	0.15
Station man	0.36
Station man	0.46
Scraper operator	0.19
Scraper operator	0.47
Treaterman	0.24
Louvre man (treater)	0.11
Louvre man (treater)	0.12
Dump floorman	0.40
Dump floorman (main flue)	0.17
Furnace operator	0.15
Furnaceman	0.17
Repairman	0.48
Change floor operator	0.32
Cleaner	0.27
Funnel loader	0.43
Arsenic roaster foreman	0.17
Arsenic loader	0.04
Arsenic loader	0.06
Arsenic loader	0.14
Arsenic loader	0.19
Arsenic loader	0.29
Mean	0.24
Median	0.17

FIGURE XI-1

CALIBRATION SETUP FOR PORTABLE PUMPS WITH FILTERS.

FIGURE XI-2
ARSINE GENERATOR

A **GENERATOR**
   125 ml erlenmeyer

B 19/38

C **SCRUBBER**
   lead acetate on
   borosilicate glass wool

D 12/2 ball joint

E **ABSORBER**
   12 ml heavy wall
   centrifuge tube

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